COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

February 1, 1965

HENRY WARD
COMMISSIONER OF HIGHWAYS

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
DIVISION OF RESEARCH
132 GRAHAM AVENUE
LEXINGTON, KENTUCKY 40506

H.1.64.8

MEMORANDUM TO: W. B. Drake, Assistant State Highway Engineer
Chairman, Kentucky Highway Research Committee

SUBJECT: Research Report; "Construction and Interim Performance of Silica Sand-Asphalt Surfacing"; KYHPR-64-8; Part II, HPS-HPR-1(26); Logan County, R. S. Group 66(1964)

The report submitted herewith emanates from continuing efforts to develop sand-asphalt surfacing to a high degree of perfection and as a possible alternative to Class I, Type A, bituminous concrete surfaces. This type of surface excels in skid-resistance and may evolve as a preferred method of surface renewal and de-slicking for worn pavements which are otherwise structurally substantial. This report is concerned principally with observations afforded by the aforenamed, State construction project; it is, in that sense, an interim report.

Until 1956, the need for sand-type surfaces in Kentucky was fulfilled largely by Kentucky Rock Asphalt. When rock asphalt became unavailable commercially, attention naturally shifted to synthetic sand-mixes. Two major bridges, the Clark Memorial Bridge in Louisville and the Ashland - Coal Grove Bridge, were surfaced with hot-mixed sand-asphalt in 1958. Some documentary references to earlier studies on this subject are provided in the report. Our research activities in this, and other major areas of interest, became part of the Department's cooperative Planning and Research Program - with the Bureau of Public Roads - in 1963.

The Logan County projects revealed two factors which could affect the future operational status of sand mixes. One of these, of course, is the matter of "tearing" or "pulling" by the paving machine. The other factor is principally that of daily production volume; and, very probably, this factor alone will adversely affect future bid prices. However, additional experience with the material may resolve these problems.

I urge continued consideration of this type of surfacing and recommend scheduling additional projects for the forthcoming construction season. I think it would be wise to limit the use of these sand surfaces to pavements which have or will have an underlying foundation course of bituminous concrete. I suggest also that any leveling be done with our Class I, Type A mix.

Any comments or suggestions relative to this study project will be appreciated.

Respectfully submitted,

Jas. H. Havens
Director of Research
Secretary, Kentucky Highway
Research Committee

Attachment

cc: Research Committee
A. O. Neiser
T. J. Hopgood
R. L. Campbell
R. O. Beauchamp
J. Paul Hunter
Harold G. Mays
S. T. Collier

Research Report

CONSTRUCTION AND INTERIM PERFORMANCE OF SILICA SAND-ASPHALT SURFACING

KYHPR-64-8; HPS-HPR-1(26)
Logan Co.; R. S. Group 66(1964)

by

Robert L. Florence
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Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

in cooperation with the
BUREAU OF PUBLIC ROADS
U. S. Department of Commerce

February, 1965

INTRODUCTION

In early October, sand-asphalt surfacing was placed on several sections of streets in Russellville, Auburn, Adairville, and Lewisburg. This was the first all-sand mix produced and laid according to the requirements of "Special Provision for Sand-Asphalt Surface" which was approved in August, 1962. Although bids had been taken in September, 1962, for thin sand-asphalt resurfacing on three bridges in Campbell and Kenton Counties, they were rejected. The "Special Provision..." was developed from previous laboratory and field test work on silica sand-asphalts (1) (2) (3) (4).

The lack of construction experience with the material was sufficient inducement to make a close study of the construction and performance of this project. Dixie Pavers Inc. of Hopkinsville was awarded the contract, on August 21, 1964. The work involved producing and laying 3,945 tons of sand-asphalt surface on 31 sections of streets, totaling 6.398 miles in length.

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(1) Strunk, L. H., "Memorandum Report on Bridge Resurfacing with Silica Sand-Asphalt Mixture," Intra-Departmental Report, Highway Materials Research Laboratory, Kentucky Department of Highways, December, 1958.

(2) Florence, R. L., "The Design of Thin, Silica Sand-Asphalt Wearing Surfaces for Highways and Bridges," Intra-Departmental Report, Highway Materials Research Laboratory, Kentucky Department of Highways, July, 1959.

(3) Florence, R. L., "Performance Report on Bridge Resurfacing with Silica Sand-Asphalt Mixture," Intra-Departmental Report, Highway Materials Research Laboratory, Kentucky Department of Highways, March, 1961.

(4) Havens, J. H., "Memorandum Report Sand-Asphalt Surface Specification," Intra-DepartmentalReport, Highway Materials Research Laboratory, Kentucky Department of Highways, April, 1961.

The surfacing was to be laid approximately 3/4-inch thick; however, an additional 1/4-inch was allowed for leveling and patching. The tack coat was RS-1, and 3,630 gal. were specified for the project. The bids varied from a low of $9.90 per ton to a high of $14.65 per ton. The total low bid for the project was $34,571.45.

The condition of the streets prior to surfacing varied considerably; most of the sections had a bituminous surface, such as shown in Fig. 1; but some were traffic-bound surfaces having very little thickness. The traffic-bound surfaces were shaped with a grader and did not receive a prime coat (Fig. 2). A few sections, such as Parrish Avenue in Russellville and Peterson Avenue in Auburn (Fig. 3), were very rough; and it was necessary to add some crushed stone for leveling. The streets surfaced, the condition of the existing surface, and the asphalt content of the sand-asphalt mixture are indicated on the maps shown in Figs. 4 through 7.

LAYING SAND-ASPHALT SURFACING

Rhea Boulevard, in Russellville, was paved first. The sand-asphalt mat was torn severely by the extruding mechanism of the paver (Fig. 8), and an undue amount of hand labor was required to repair the torn areas; this, of course, caused delays in the paving operation (Fig. 9). On the wider streets, two pavers were used; and the mat was torn by each paver. It was noted that the tearing was much less severe on streets which were relatively flat in cross-section than on the streets having a high crown. The vibrators in the paver screeds were turned off shortly after starting the work, and this reportedly reduced the tearing.

In the course of the project, several adjustments were made in the composition and temperature of the mixture to reduce or eliminate the tearing. On a portion of Rhea Blvd., the asphalt content was reduced from 9 percent to 8 percent, but this appeared to have little effect on the tearing. The morning of October 7, in an effort to make the mix "less sticky," the natural sand content was increased to approximately 65 percent of the aggregate; and, a short time thereafter, the asphalt content was reduced to 8.5 percent. No other changes were made in the composition of the mixture. The temperature of the mixture was raised to 375°F, for a short period of time.

The thickness at which the material was laid and the type of substrate on which the material was laid appeared to have no relation to the tearing. A light tack coat was used on most of the streets. An ample application of tack was made on Hopkinsville Street in Russellville. It is believed that an ample but uniform tack coat is essential to good performance of this type mixture(4).

The finished mat had a fine-textured, pleasing appearance even though the tearing was never fully eliminated. Tandem rollers were used to compact the sand-asphalt (Fig. 10). Although the material had a low Marshall stability and was laid hot, it was displaced very little by the rollers when laid 3/4-inch thick. The rollers bridged across and did not fully compact many of the torn areas which were low after being repaired by raking and adding material. It is anticipated that traffic will iron-out and improve the appearance of the surface. Several views of

the finished sections of pavements are shown in Figs. 11 through 14.

Pulling or tearing of the same type was experienced when sand-asphalt surface was laid 0.4-inch thick on the Clark Memorial Bridge in Louisville (1). There, the aggregate was composed of a blend of river sand, bank sand, and portland cement filler. The asphalt content of the mixture was 9 percent. Tearing of the mat on the Clark Bridge was eliminated by adjusting the tamping bars of the Barber-Greene pavers and by reducing the proportion of the bank sand. It was reported that variations in temperature of the mixture and speed of the pavers had little effect on the tearing.

PRELIMINARY MARSHALL MIX DESIGN

In mid-September a Marshall design was performed by Research Division Personnel on aggregates which the Contractor proposed for use in the mixture. The type of aggregates and the proportions of each used in the design were as follows:

Natural Sand (mortar sand)	55 percent
Limestone Sand	37 percent
Coarse Limestone Dust	5 percent
Fine Limestone Dust	3 percent

The natural sand was from the Henderson Materials Company and the limestone aggregates were from the Hopkinsville Stone Company. A microscopic examination of the natural sand indicated that approximately 90 percent of the sand was quartz. Thus, to fulfill the requirement that quartz (SiO_2) comprise a minimum of 50 percent of the combined aggregate, it was necessary that a minimum of 55

percent of the aggregate be natural sand. The gradations of the aggregates are shown in Table 1.

Results of the Marshall design are shown in Fig. 15. If the usual mix design criteria were applied, the optimum asphalt content would be about 10.4 percent. However, it is believed that the usual mix design criteria are not wholly applicable to sand-asphalts when used for thin resurfacings (4). An asphalt content of 9 percent was selected so that the mix would have sufficient voids to absorb any excess tack. It is also believed that high void contents in sand-mixtures adds to the skid-resistant qualities of the surface.

PRODUCTION AND PLANT CONTROL

The material was produced at Dixie Paver's plant at Hopkinsville. The plant was a Hetherington-Berner batch equipped with a mineral filler feeder. The Special Provision required that the plant be equipped with a separate bin for metering collected dust back into the mixture. When mineral filler is used, a separate bin is also required from which the mineral filler can be weighed into the mixture. This plant was equipped with only one bin from which collected dust or mineral filler could be weighed into the mixture; therefore, a change order was obtained to allow the collected dust to be returned at the bottom of the hot-elevator.

A 1/8-inch screen is about the finest size screen used on a hot-mix plant. As all sand-asphalt aggregate is required to pass the No. 8 screen; all aggregate, with the exception of mineral

filler, will go into the fine-bin of the gradation unit. The gradation unit of the plant serves only to scalp-off oversize material (plus 1/8-inch) and to store the dried and heated aggregate. Uniformity in gradation of the finished mixture is entirely dependent upon the uniformity in gradation of the stockpiled aggregates and on the accuracy of proportioning of the cold-feed mechanisms. Natural sand, limestone sand, and coarse limestone dust were proportioned from the cold-feed bins and put through the dryer. The fine limestone dust was fed through the mineral filler system and weighed into the mix, without heating, from a separate bin. To insure that the coarse limestone dust would feed uniformly it was pre-blended with a coarser limestone sand prior to loading it into the cold-feed hopper. As already stated, the plant was equipped with a 1/8-inch screen, and a small portion (approximately 0.3 to 0.4 percent) of the aggregate was within the 1/8-inch to No. 8 sieve range. On October 5, the cold-feed was initially set for the following approximate proportions of aggregates:

Natural Sand	55 percent
Limestone Sand	34 percent
Limes. Dust and Limes. Conc. Sand Blend	5 percent
Fine Limestone Dust	6 percent

The asphalt content was set at 9 percent, but when the tearing was noted on the road, the asphalt content was reduced to 8 percent for a short period of time in the afternoon. The proportion of fine limestone dust was reduced to 4 percent for the remainder of the project. In an effort to make the mixture "less sticky" and, thereby, to reduce the tearing, the proportion of

natural sand was increased to approximately 65 percent and the asphalt content was reduced from 9 percent to 8.5 percent in the morning of October 7. The proportions of materials were then held constant for the remainder of the project.

The results of gradation tests, performed by the Plant Inspector, are shown in Table II. It may be noted that at times the gradation was near or outside the Specification limits on the No. 100 and No. 50 sieves, particularly when the proportion of natural sand was increased to 65 percent. The results of extraction tests performed by the Plant Inspector and by District Materials personnel are shown in Table III. A sample of the mixture was taken at the paver in the afternoon of October 7th and in the morning of October 8th. Results of laboratory tests on the samples are shown in Table IV.

Because of limitations in the rate of drying and screening the fine sand-asphalt aggregates, the plant production rate was reduced considerably. The daily tonnages for the project were as follows:

Date	Production (tons)
Monday, October 5	493.48
Tuesday, October 6	533.81
Wednesday, October 7	666.53
Thursday, October 8	816.69
Friday, October 9	952.51
Saturday, October 10	602.70
Total	4065.72

The total tonnage over-ran the bid quantity by 120.7 tons (or approximately 3 percent). This, of course, was occasioned by the

amount of the material needed to correct the roughness of many of the streets.

PERFORMANCE OF SURFACING

An inspection was made, in mid-December, of the condition of the sand-asphalt surfacing after two months of service. All of the sections laid over a bituminous pavement appeared to be in much the same, good condition as immediately after surfacing. A failure resulting from moisture in the subgrade is shown in Fig. 16. Virtually all of the surfacing laid over traffic-bound base is exhibiting roughness such as shown in Fig. 17. It is believed that the roughness is a result of instability of the base. No cracking, other than that shown in Fig. 16, was noted in any of the sections surfaced.

Additional inspections will be made periodically, and other performance reports will be issued from time to time.

RECOMMENDATIONS

On the basis of the experience gained, it is recommended that the specifications for this type of work be amended in accordance with the proposed revisions appended hereto.

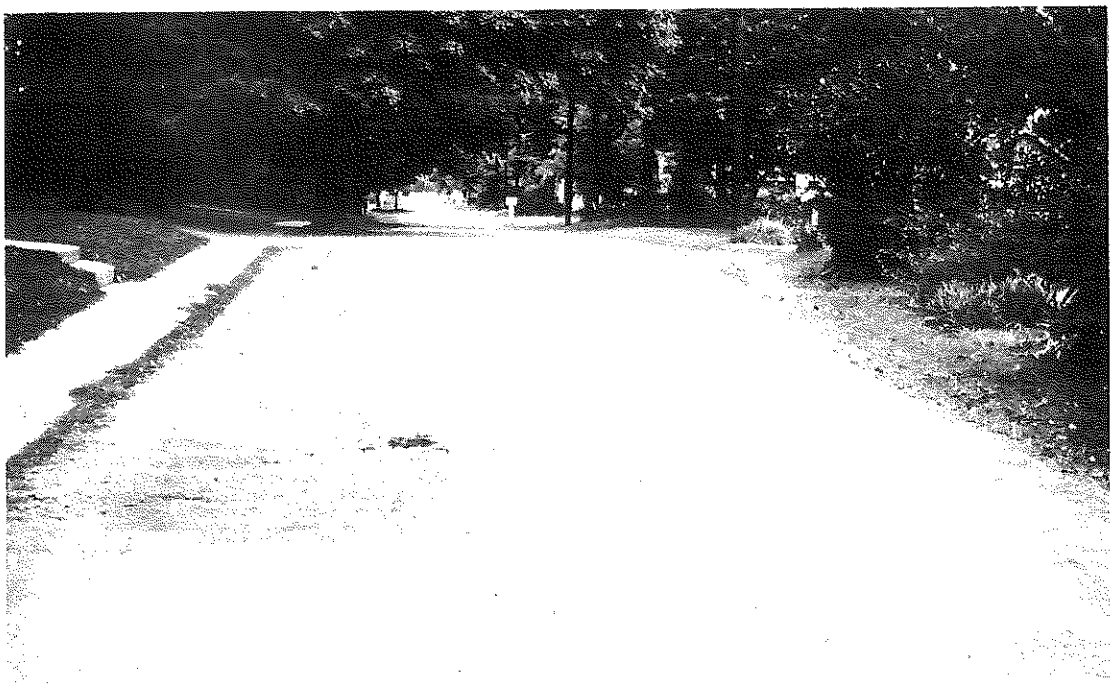

Fig. 1. Condition of Bituminous Surface on Walnut Street in Auburn, October 4, 1964.

Fig. 2. Shaped, Traffic-Bound Surface on Russell Street in Russellville, October 7, 1964.

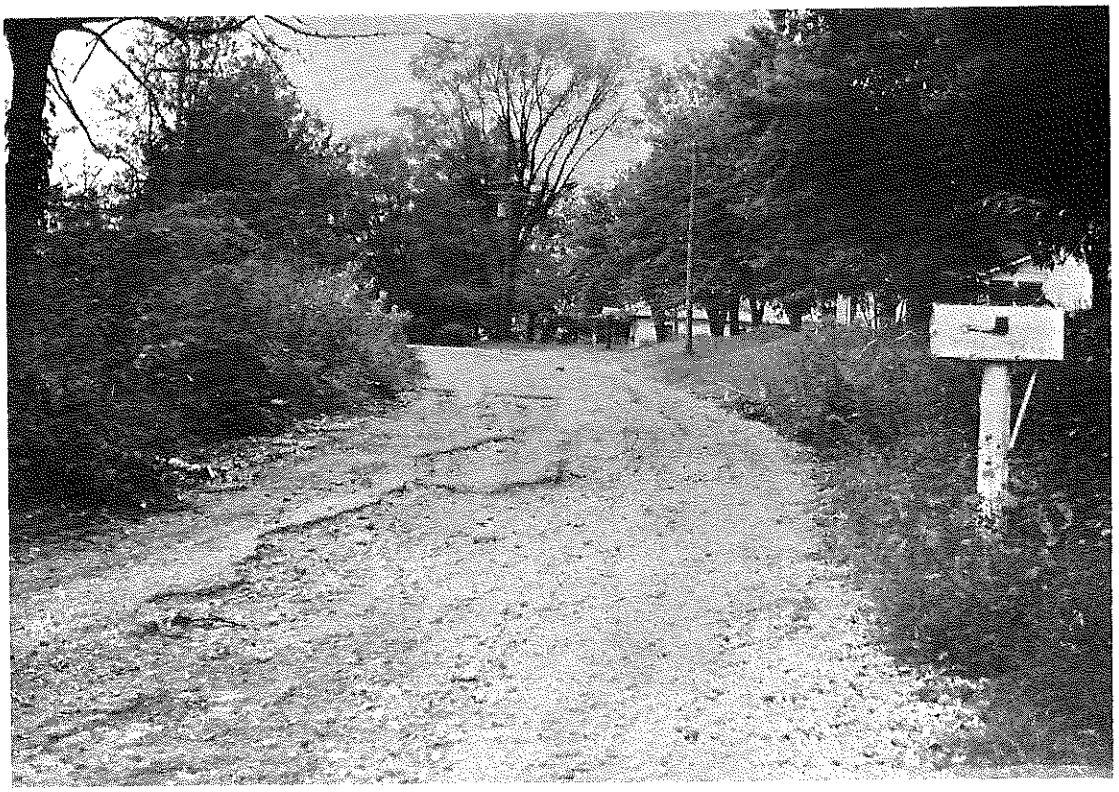

Fig. 3. Rough Section of Peterson Avenue in Auburn, October 4, 1964. Fig. 14 shows this same location afterwards.

Fig. 4. Russellville. The streets paved with sand-asphalt are shaded. The asphalt content of the mixture is indicated and the condition of the old surface is indicated in parentheses.

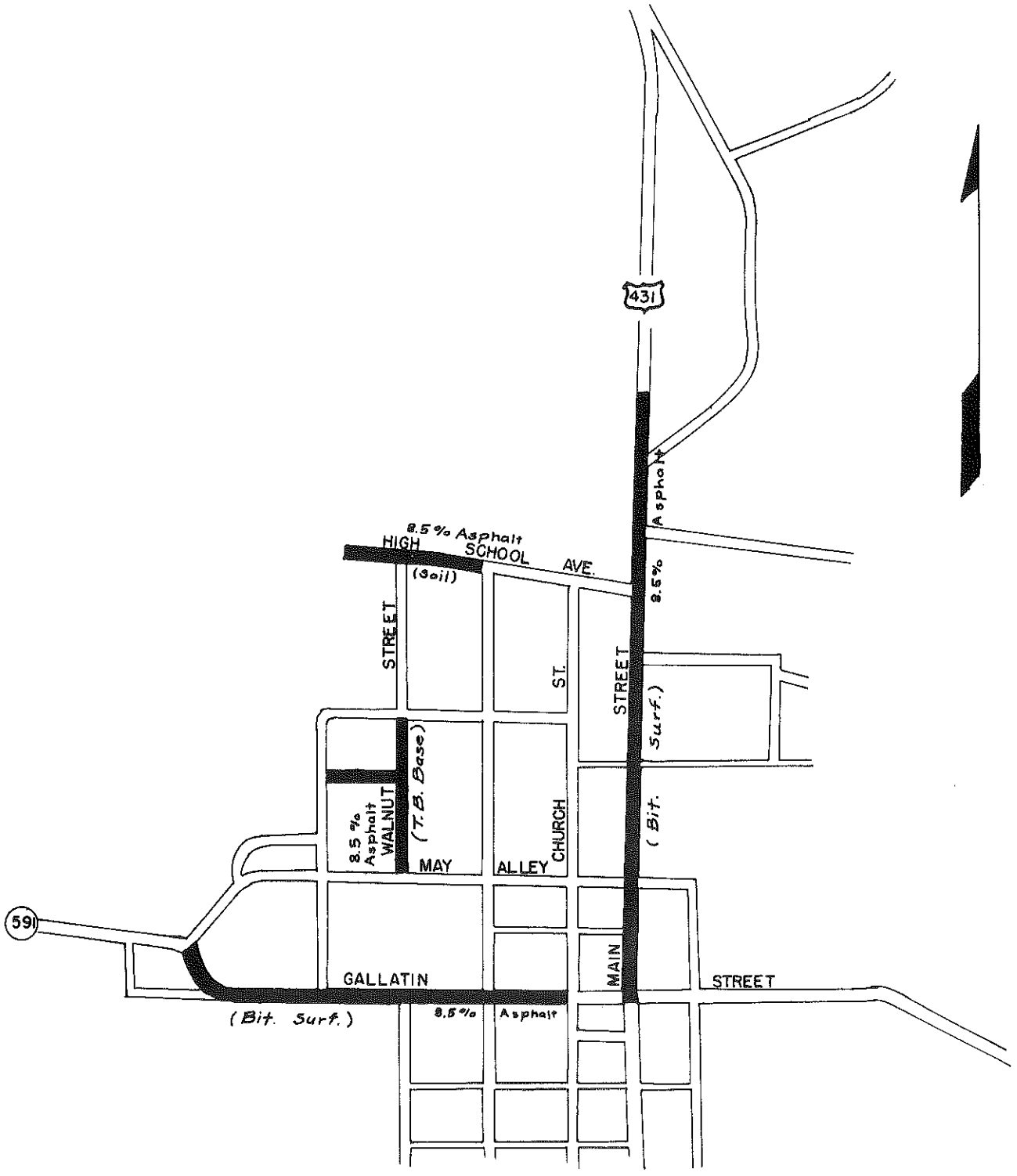

Fig. 5. Adairville. The streets paved with sand-asphalt are shaded. The asphalt content of the mixture is indicated and the condition of the old surface is indicated in parentheses.

AUBURN

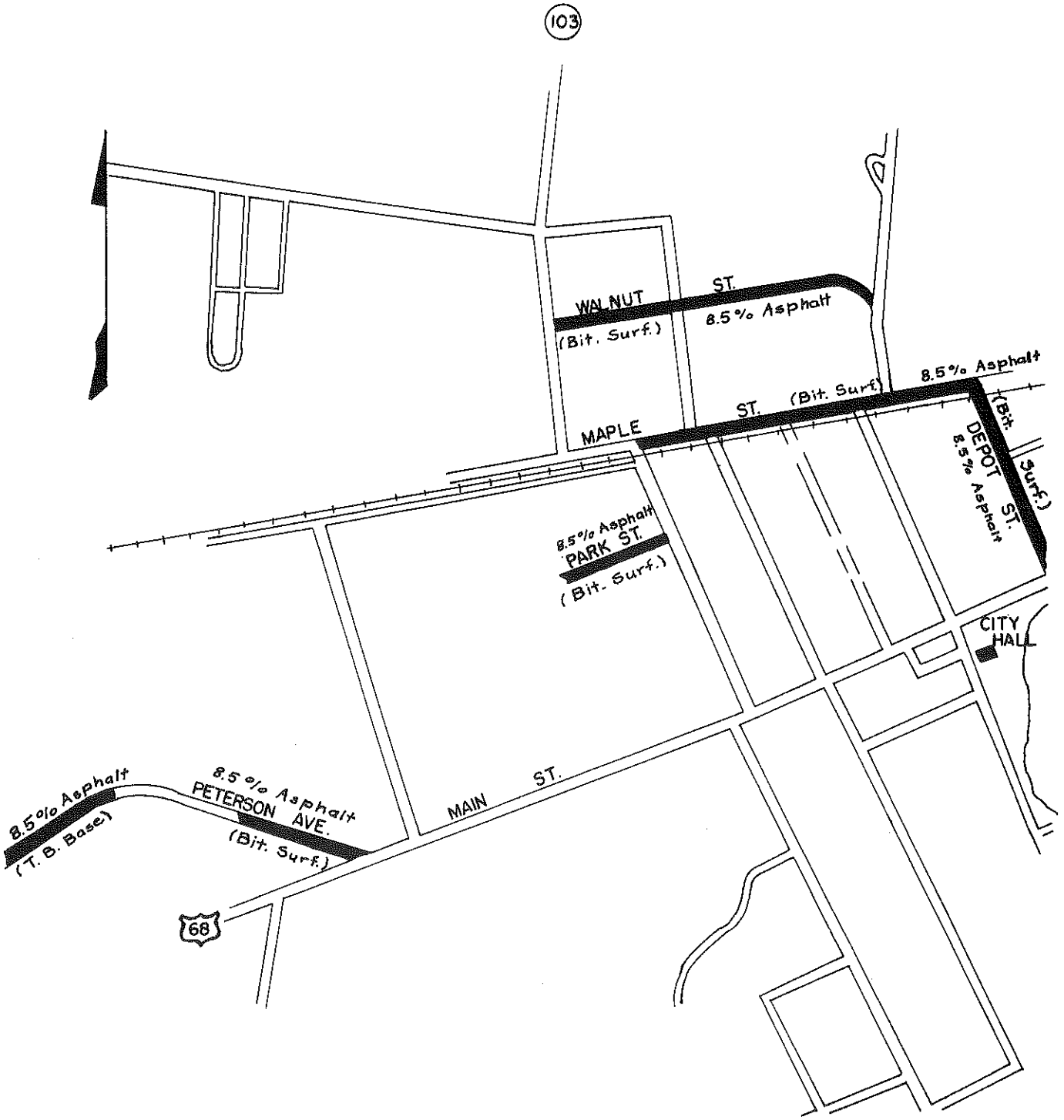

Fig. 6. Auburn. The streets paved with sand-asphalt are shaded. The asphalt content of the mixture is indicated and the condition of the old surface is indicated in parentheses.

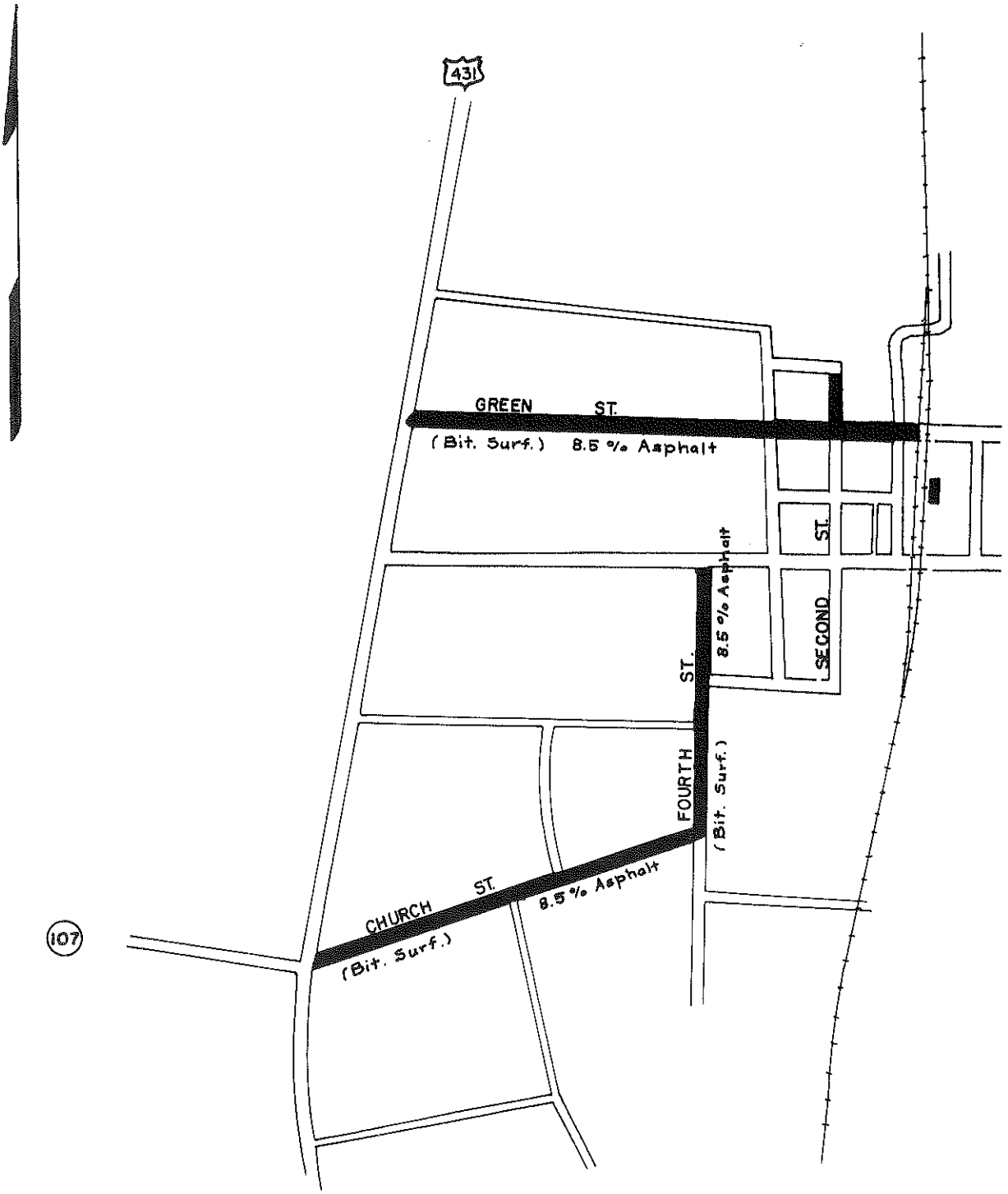

Fig. 7. Lewisburg. The streets paved with sand-asphalt are shaded. The asphalt content of the mixture and the condition of the old surface is indicated in parentheses.

Fig. 8. Example of Severe Tearing of Extruded Mat; Rhea Blvd. in Russellville.

Fig. 9. Raking Torn Areas in Extruded Mat; Rhea Blvd. in Russellville.

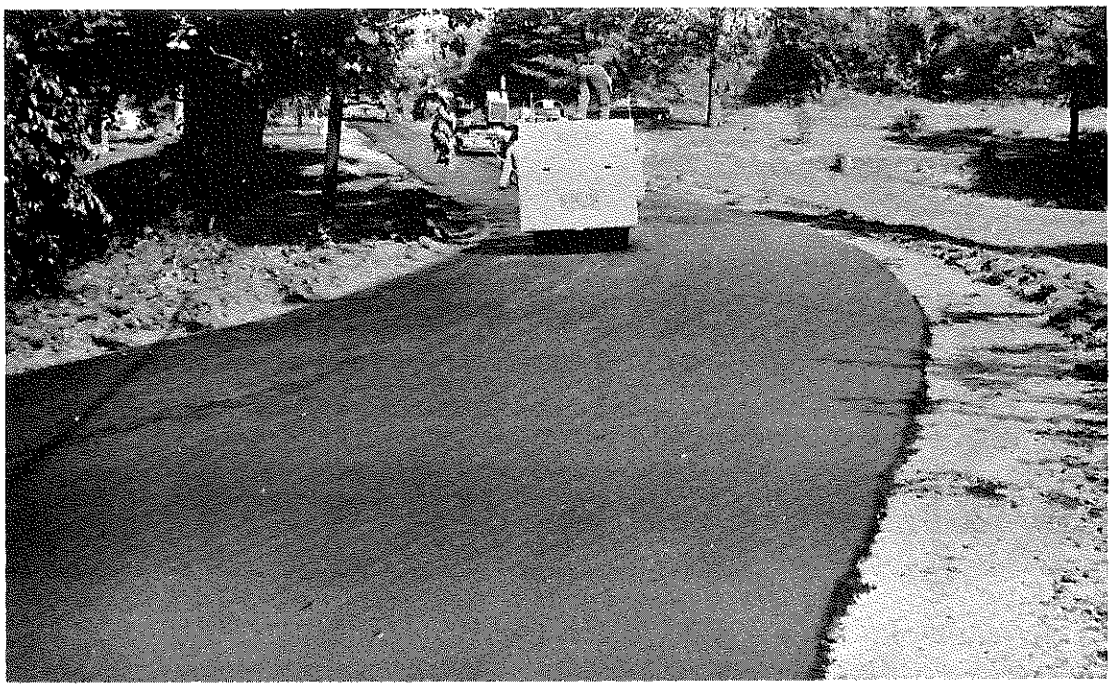

Fig. 10. Compacting Mat; Rhea Blvd. in Russellville.

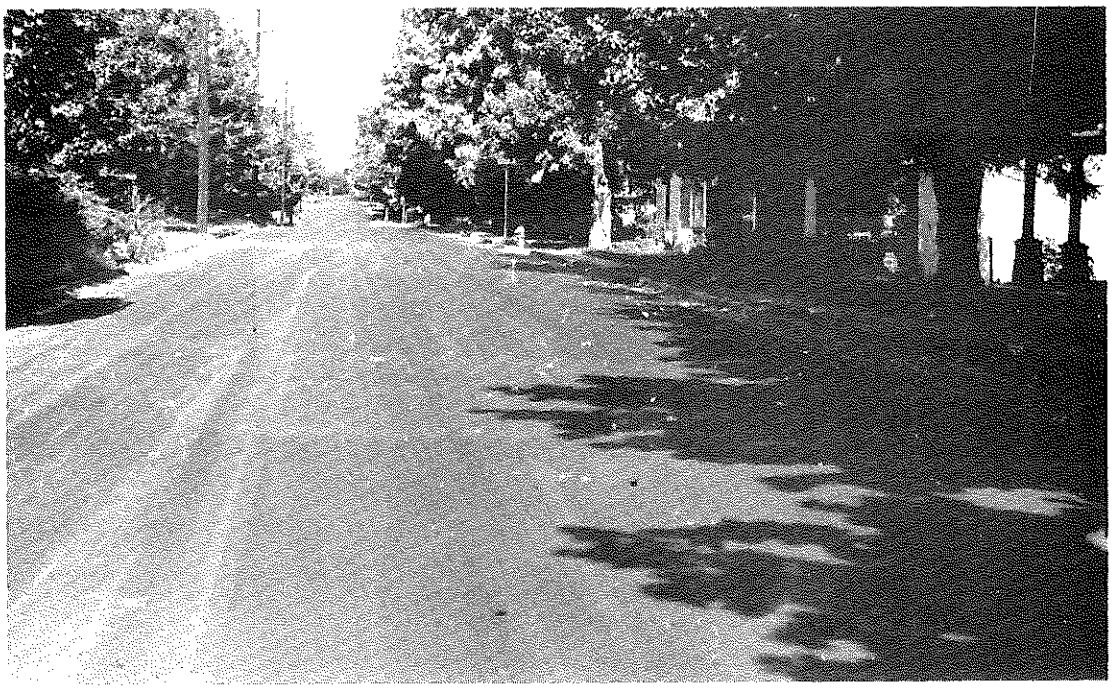

Fig. 11. Finished Surface, Main St. (US 431) in Adairville; October 14, 1964.

Fig. 12. Finished Surface, Walnut St. in Auburn; October 14, 1964. Fig. 1 shows the same scene, before resurfacing.

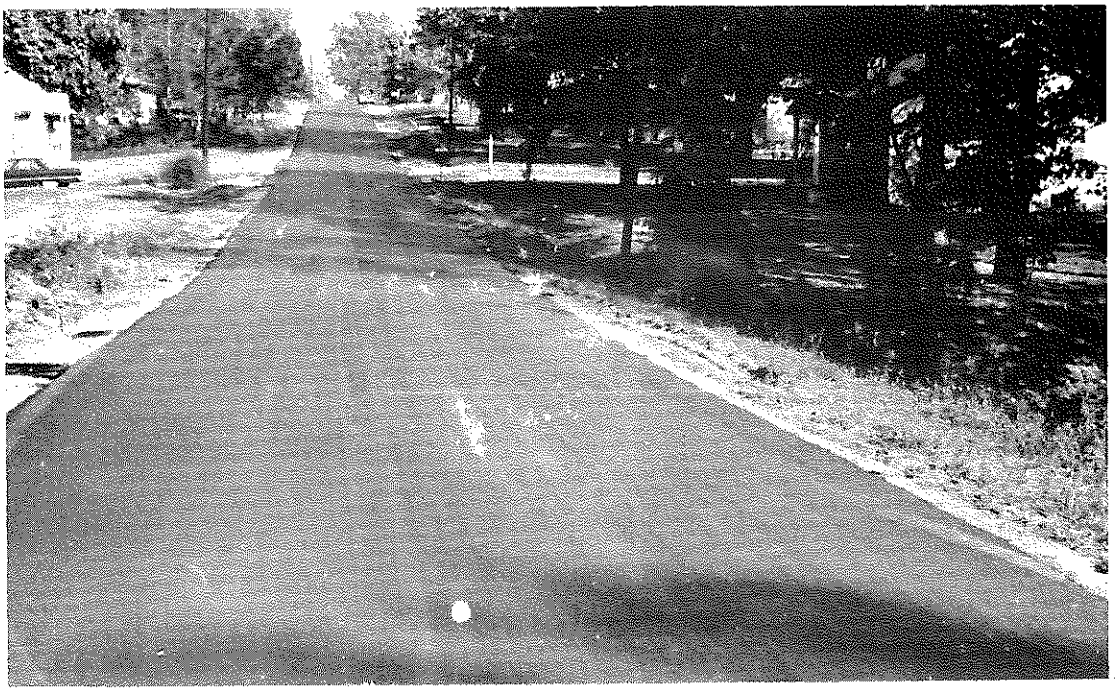

Fig. 13. Finished Surface, Green St. in Lewisburg; October 13, 1964.

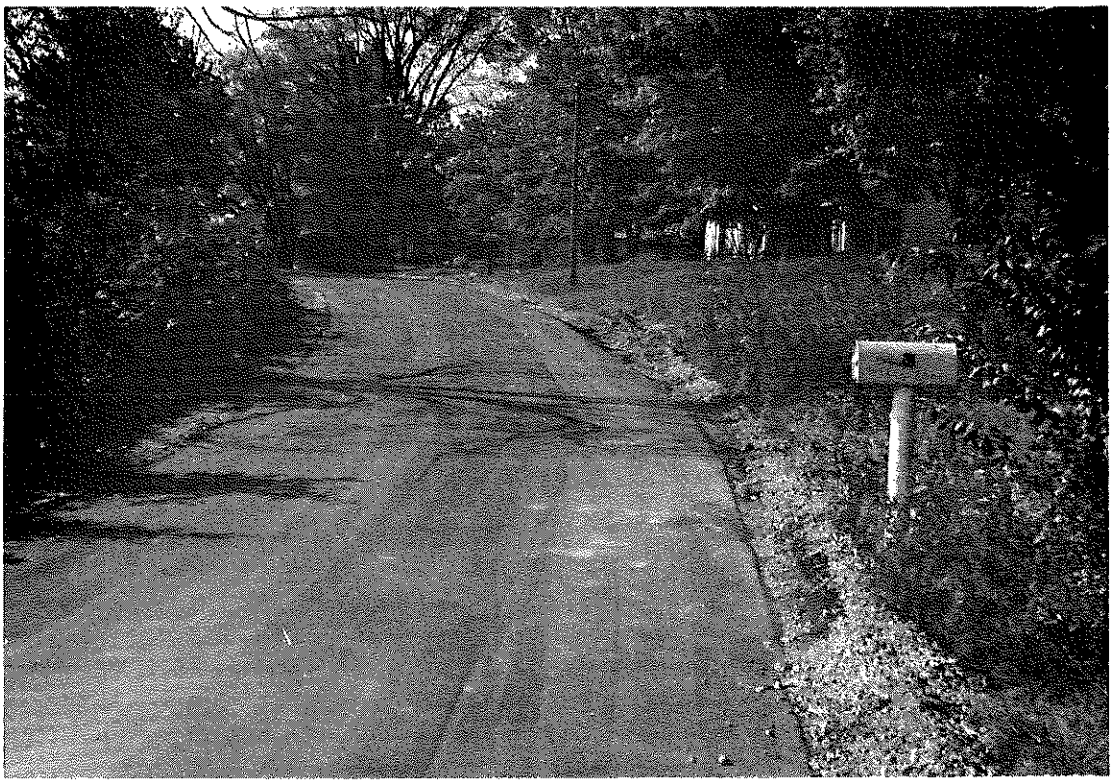

Fig. 14. Finished Surface, Peterson Ave. in Auburn; October 14, 1964. Fig. 3 shows the same scene, before resurfacing.

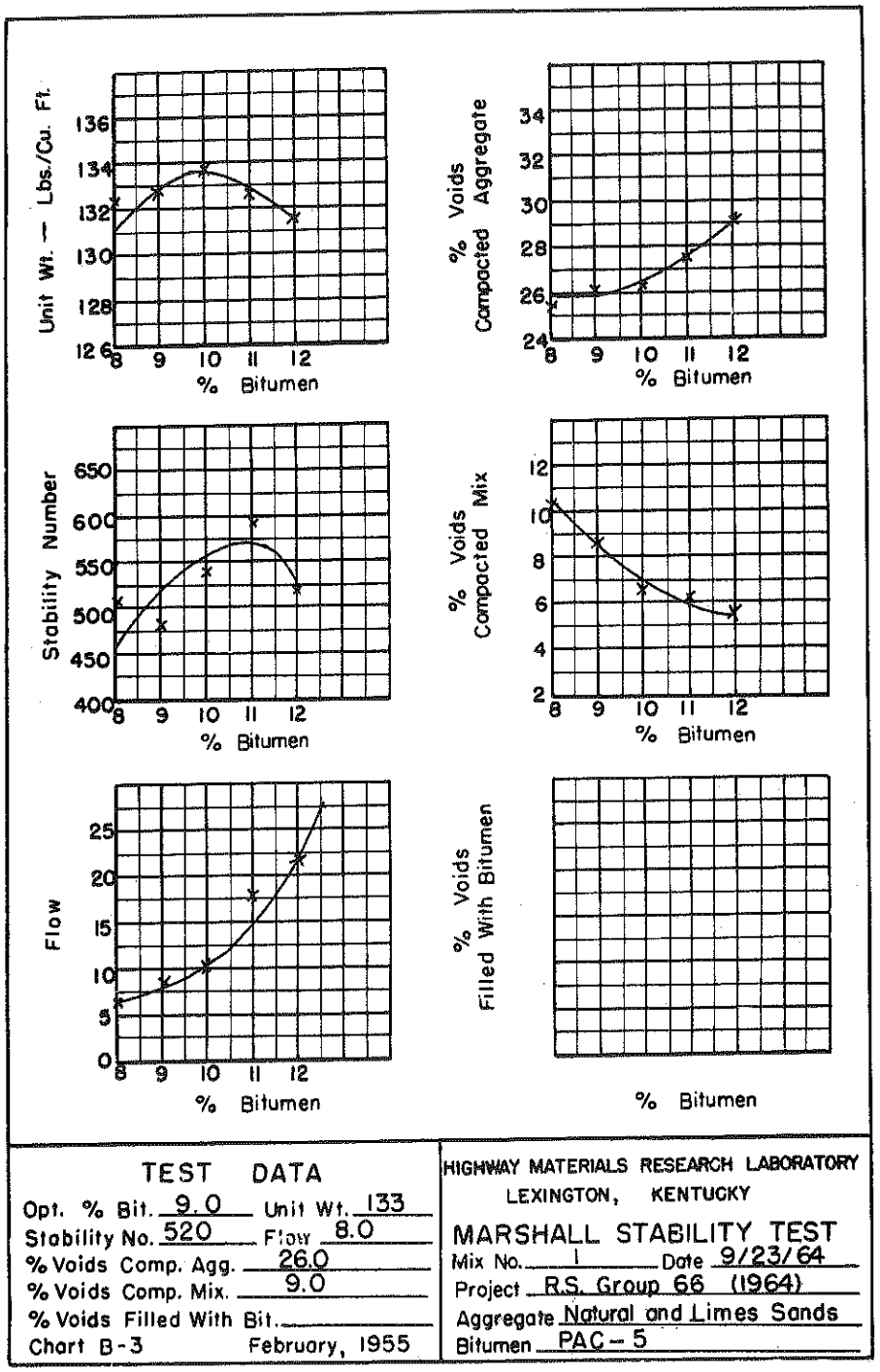

Fig. 15. Graphical Representation of Results of Marshall Mix Design.

Fig. 16. Pavement Failure, Church Street in Lewisburg; December 16, 1964. The failure was obviously caused by moisture in the subgrade.

Fig. 17. Wildwood Ave. in Russellville; December 17, 1964. Virtually all of the surfacing laid over traffic-bound base exhibited this rippled condition.

TABLE I.

MARSHALL DESIGN GRADATIONS

Sieve Size	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
Natural Sand	100	99.9	97.4	77.8	14.3	0.8	0.1
Limestone Sand	100	99.8	93.8	60.5	33.6	14.7	6.6
Coarse Limestone Dust	100	99.8	99.6	98.8	92.9	69.1	43.3
Fine Limestone Dust	100	100	99.9	99.6	98.5	86.8	55.1
Combined Gradation	100	99.9	96.3	73.1	27.9	11.9	6.3
Specification Limits	-	100	55-100	35-100	25-65	10-30	2-10

TABLE II.

GRADATION OF BIN SAMPLES

Date	Sieve Size No.8	No. 16	No.30	No.50	No.100	No.200	Fineness Modulus
10-5-64 (A.M.)	100	89.4	73.2	30.8	10.0	5.0	1.96
10-5-64 (P.M.)	100	85.8	67.9	27.9	10.0	4.2	2.08
10-6-64 (A.M.)	100	80.8	58.4	27.8	12.0	6.6	2.11
10-6-65 (P.M.)	100	83.2	62.8	33.2	15.0	7.6	2.06
10-7-64 (A.M.)	100	92.4	78.0	30.6	9.2	4.8	1.90
10-7-64 (P.M.)	100	88.9	71.5	26.1	8.3	4.3	2.05
10-8-64 (A.M.)	100	89.2	71.8	28.4	8.0	4.6	2.03
10-8-64 (P.M.)	100	88.7	70.2	27.3	8.2	4.1	2.06
10-9-64 (A.M.)	100	85.6	66.2	27.8	10.6	6.6	2.10
10-9-64 (P.M.)	100	84.7	66.1	26.6	10.2	5.8	2.12
10-10-64 (A.M.)	100	83.2	64.2	26.6	10.3	4.6	2.16
10-10-64 (P.M.)	100	84.0	64.3	25.8	10.1	4.2	2.16

TABLE III.

EXTRACTION TEST RESULTS

Date	Asphalt Content %	Sieve Size No.8	No.16	No.30	No.50	No.100	No.200	Fineness Modulus
Extraction Tests by Plant Inspector								
10-5-64	8.9	100	87.2	70.2	30.3	9.9	5.1	2.02
10-6-64 (A.M.)	8.8	100	90.3	74.4	27.9	8.4	3.8	1.99
10-6-64 (P.M.)	8.9	100	78.0	56.7	28.7	13.5	6.9	2.23
10-7-64 (A.M.)	9.0	100	90.1	74.7	31.6	10.9	5.6	1.93
10-7-64 (P.M.)	8.8	100	83.1	63.2	24.4	6.0	3.1	2.23
10-8-64	8.5	100	86.0	66.5	23.6	10.5	5.5	2.13
10-9-64	8.6	100	85.0	66.2	26.9	10.1	4.4	2.12
10-10-64	8.4	100	86.2	67.8	27.6	10.2	4.3	2.08
Extraction Tests by District Materials Personnel								
10-5-64	8.7	100	86.2	66.2	23.2	8.1	3.9	
10-6-64	8.5	100	77.7	56.4	28.0	14.4	3.7	
10-7-64	9.1	100	88.7	71.4	25.8	10.0	5.1	
10-8-64	8.9	100	88.3	69.1	24.1	7.3	3.7	
10-9-64	7.8	100	85.2	65.4	23.5	8.1	4.5	

TABLE IV.

LABORATORY TEST RESULTS SAMPLED MIXTURES

Asphalt Content	(Percent)
Sample A, 10-7-64	7.7
Sample B, 10-8-64	7.6

Gradation of Extracted Aggregate (Percent Passing)

Sieve Size	No. 4	No. 8	No. 16	No. 30	No. 50	No.100	No. 200
Sample A, 10-7-64	100	99.7	87.2	70.1	21.8	4.0	1.5
Sample B, 10-8-64	100	99.6	83.0	66.7	20.4	4.4	1.7

Marshall Test Results (Reheated Mixture)

	Sample A, 10-7-64	Sample B, 10-8-64
Stability (lbs.)	240	387
Flow (0.01 in.)	9	10
Unit Weight (lb./cu.ft.)	125.9	127.9
Voids in Aggregate (%)	28.3	27.2
Voids in Mixture (%)	14.8	13.6

PROPOSED REVISION OF SPECIAL PROVISION

A proposed revision of the Special Provision for Sand-Asphalt Surface is attached. Following is a detailed discussion of the proposed revision.

I. DESCRIPTION

The wording of the second sentence has been changed to clarify the types and relative amounts of aggregates permitted or required. In the last sentence, the restriction of 0.5 inch course thickness is omitted to allow for judicious fitting of the course thickness to the condition (roughness) of the existing pavement in resurfacing work.

II. MATERIALS

A. Requirements.

1. Bituminous Materials. The wording of the first paragraph has been changed to agree more closely with the wording of the corresponding paragraph of Amendment 45.

2. Aggregate. The first part of the paragraph has been reworded to clarify the requirements pertaining to acceptable types of aggregates. No real changes are made in the types of aggregates required. In the latter part of the paragraph, the physical requirements of the aggregate have been changed and are stated more specifically. These physical requirements should facilitate testing of aggregates from new sources. The physical requirements are for the total combined aggregate and, with the exception of a wear requirement, are identical with the physical requirements for fine aggregates as stated in the

Special Provision for Aggregates for Bituminous Concrete Mixtures, approved February 28, 1964.

III. PLANT AND EQUIPMENT

Reference is made to Article 4.3.3 of the Standard Specifications. This in effect deletes the requirement for a bin to store collected dust. It was necessary to obtain a change order deleting the bin requirement for the Logan County sand-asphalt resurfacing work.

IV. PREPARATION OF MIXTURES

A. Composition of Mixtures. No real changes were made in the requirements of the first paragraph, but the wording was changed to agree more closely to the wording of Article 4.3.4-A. In the tabulation of Composition Limits, the nominal, top size of the aggregate has been increased to 1/4-inch. This larger aggregate size will better fit the commonly available aggregates and should reduce or eliminate the necessity of pre-processing aggregates prior to stockpiling at the hot-mix plant. A 1/4-inch screen is more commonly used on hot-mix plants than is the No. 8 screen; and, its larger screening capacity will lessen the possibility of a production bottleneck at the gradation unit. Other modifications were made in the composition limits to guard against the possibility of producing tough, hard-to-lay mixtures. These modifications consist of raising the lower limit on the No. 16 and No. 30 sieves, lowering the lower limit on the No. 100 sieve, and lowering the upper limit on the No. 30 sieve from 100 to 95 percent.

B. Preparation of Aggregates. No changes were made in the requirements. The first and last sentence have been reworded for clarification.

PROPOSED REVISION

OF

SPECIAL PROVISION

FOR

SAND-ASPHALT SURFACE

This Special Provision covers the material requirements and construction methods for Hot-Mixed, Hot-Laid, Sand-Asphalt, Surface Course and shall be applicable to individual projects only when indicated on plans, proposals, or bidding invitations; and, when so indicated, it shall supersede all conflicting provisions of the Department's current Standard Specifications for Road and Bridge Construction. References herein are to the Department's Standard Specifications and approved addenda thereto.

I. DESCRIPTION

Hot-Mixed, Hot-Laid, Sand-Asphalt is intended to provide a fine-textured, skid-resistant, wearing surface for pavements and bases. At least 50 percent of the sand therein shall consist of quartz (SiO_2). A proportion of the sand may consist of crushed limestone or slag sand. The sand, bituminous material, and the mixing and application thereof shall be in accordance with the respective requirements hereinafter described. The mixture shall be applied to the nominal, compacted thickness indicated on the plans or in the proposal; and the finished surface shall conform with the lines and grades shown on the plans or proposals.

II. MATERIALS

A. Requirements.

1. Bituminous Materials. The asphalt cement to be mixed with the sand shall be of the grade specified on plans or proposals and shall meet the particular requirements of Article 7.7.0. The quantity of asphalt cement used shall be as directed by the Engineer.

Bitumen for the tack coat shall meet the requirements of Article 7.7.0 for the particular type and grade specified on the plans or proposals.

2. Aggregate. The aggregate shall consist, by weight, of not less than 50 percent quartz (SiO_2). Quartz, to fulfill this requirement, shall be obtained from crushed sandstone, conglomeratic sand, bank sand, river sand or combinations thereof. The remaining portion of aggregate shall consist of quartz sand, limestone sand, slag sand, or blends thereof. Mineral filler meeting the requirements of Article 7.3.6 may comprise not more than 5 percent of the aggregate combination. The total combined aggregate, including mineral filler, shall have a minimum Sand-Equivalent value of 35, as determined by AASHO T 176. Deleterious substances retained on the No. 200 sieve shall not exceed the following percentages by weight of the total combined aggregate.

	Percent by Weight
Clay lumps	None
Other deleterious substances such as, but not limited to, alkali, mica, shale, coated grains, soft and flaky particles	1.0

B. Approval of Materials. Article 4.3.2-B

III. PLANT AND EQUIPMENT

Article 4.3.3

IV. PREPARATION OF MIXTURES

A. Composition of Mixtures. The sand and asphalt cement shall be combined in such proportions that the composition of the mixture by weight shall be within the general limits given in the following table. A job-mix formula, within the specified composition limits, shall be established by the Engineer for each project; and the proportions and gradings so set shall be maintained within the tolerances specified hereinafter. The percentages passing all sieve sizes shall be determined by dry sieving. These permissable tolerances from the job-mix formula shall not permit the use of any mixture which will be outside the specified composition limits. Once the job-mix formula has been established, it shall remain in effect until changed in writing by the Engineer. Deviations from the job-mix formula shall not exceed 0.5 percentage points in the asphalt content, 0.2 in fineness modulus of the sand gradation, and 1.5 percentage points in the amount of material passing the No. 200 sieve.

Composition Limits

Sieve	Per Cent Passing
1/4-inch	100
No. 8	90-100
No. 16	75-100
No. 30	50-95
No. 50	25-65
No. 100	7-30
No. 200	2-10
Per Cent Bitumen	---- 7-10

B. Preparation of Aggregates. If sands from two or more sources are blended, they shall be metered from individual cold bins in such proportions that will yield a product having the specified gradation. The sand shall be uniformly dried and heated to a temperature of not less than 225 degrees F. nor more than 325 degrees F. If mineral filler is used, it shall be weighed or metered into the mix from a separate bin.

C. Preparation of Asphalt Cement. Article 4.3.4-C

D. Preparation of Mixture. Article 4.3.4-D

E. Temperature Requirements. Article 4.3.4-E

V. CONSTRUCTION METHODS

Article 4.3.5

VI. METHOD OF MEASUREMENT

Article 4.3.6

VII. BASIS OF PAYMENT

Article 4.3.7